

Description

**METHOD AND COMPOSITION FOR CLEANING AND  
MAINTAINING WATER DELIVERY SYSTEMS**

Related Applications

5        This application claims priority to provisional application  
Serial No. 60/223,215, filed August 4, 2000, and to provisional  
application Serial No. 60/280,447, filed March 29, 2001.

Technical Field

10        This invention relates to a method and composition for  
cleaning and maintaining water storage and/or distribution  
systems. More particularly, it relates to the use of a reacted  
mixture of a sodium chlorite solution and a second solution  
containing an acid for inhibiting and/or removing bacterial  
fouling an/or inhibiting and/or removing mineral deposits, and/or  
15        eliminating microorganisms from water storage and/or distribution  
systems.

Background of the Invention

20        Water is stored in reservoirs and tanks and is delivered by  
conduits to places where the water is used. Water storage and  
delivery systems often become fouled and/or obstructed by mineral  
scale deposits and/or biological growths and/or bio-films.  
Irrigation systems used in the agricultural industry can  
experience fouling that is so severe that water flow is reduced  
to a level where valuable crops receive insufficient watering and  
25        perish from dehydration.

30        There is a need for compounds that can be added to water  
storage and delivery systems for eliminating the mineral and  
biological substances that cause the obstructions and comprise  
the systems. A principal object of this invention is to provide  
such a composition and a method of its use for cleaning and  
maintaining water delivery systems, including tanks, reservoirs  
and conduits.

      There is also a need for an easily achieved on-site metering  
and mixing of the components of the composition and an easily

achieved introduction of the composition into the water delivery system. Another object of the present invention is to fulfill this need.

#### **Brief Summary of the Invention**

5 A basic aspect of the present invention is to admix a sodium chlorite solution with a second solution containing an acid to make a reacted mixture. A predetermined amount of this reacted mixture is then introduced into water in a water distribution system.

10 According to an aspect of the invention, the reacted mixture is introduced into a water system to inhibit and/or eliminate bacterial fouling in the system. Another aspect of the invention is to introduce the activated mixture into to the water for inhibiting and/or removing mineral deposits from the system. Yet  
15 another aspect of the invention is to introduce the activated mixture into the water for eliminating microorganisms from the system.

According to yet another aspect of the invention, the second component is acid enough to convert the sodium chlorite into  
20 chlorine dioxide while remaining unaffected in the reacted mixture and at the same time being a mineral antiscalant. The second solution may be formed by adding PBTC and sodium molybdate di-hydrate and water. The second compound may be a mixture of mineral acids and an antiscalant polymer. The antiscalant  
25 polymer may be polyacrylic acid or a polymeric compound.

According to an aspect of the invention, a catalyst is used to enhance conversion of the sodium chlorite into an active biocide, chlorine dioxide. By way of typical and therefore non  
limitive example, the catalyst may be sodium molybdate.

30 Other objects, advantages and features of the invention will become apparent from the description of the best mode set forth below, from the drawing, from the claims and from the principles that are embodied in the specific structures, compositions and method steps that have been illustrated and described.

## Brief Description of the Several Views of the Drawing

The drawing is a flow diagram of a water distribution system and equipment for preparing the composition of the invention and introducing it into the water system.

### 5 Detailed Description of the Invention

10 The drawing shows, by way of example, a portion of an irrigation system that includes a flow meter 10 in a conduit 12, e.g. an irrigation pipe. The flow meter 10 measures the flow in the conduit 12 and generates an electrical control signal that is proportional to the flow. The electrical signal may be electrical pulses that are sent to a pulse divider 14 which generates electrical control signals that are sent to controllers for two chemical feed pumps 16, 18. The electrical signals from pulse divider 14 may be electrical pulses which control the pumps 15 16, 18 for proportionally pumping the two components that are mixed. Preferably, the pumps 16, 18 are positive displacement pumps that include pistons. The control signals control the movement of the pistons. Each pumping stroke sends a predetermined volume of chemical into a conduit 20, 22 leading from a pump 16, 18 to a reaction chamber 24. Pump 16 pumps a first solution or component from its storage tank 26 to the reaction chamber 24. Pump 18 pumps a second solution or component from its storage tank 28 to the reaction chamber 24. The two solutions are precursor chemicals that are allowed to 25 intermingle or react for the period of time, e.g. ten or more minutes, in the reaction chamber 24. The reacted mixture is removed through the top of the reaction chamber 24 and is delivered by a conduit 30 into the water conduit 12, into admixture with water that is flowing through the conduit 12. The admixture of the reacted solution in the water substantially 30 instantly dilutes the reacted mixture to a desired working concentration for distribution by conduit 12 throughout the water system.

By way of example, the flow sensor may be a Module IP115 hot-tap insertion flow sensor, manufactured by Sea Metrics, Inc., having a business address of 20419 80<sup>th</sup> Ave.S., Kent, 98032. The pulse divider may be a model PD10 pulse divider, also  
5 manufactured by Sea Metrics, Inc. The pumps may be model B711-392SI pumps manufactured by LMI Milton Roy, having a business address of 8 Post Office Square, Acton Ma 01720. The reaction chamber 24 may be an off the shelf item. It may be what is known as a reaction column that is made from schedule 80PVC pipe,  
10 measuring two inches in diameter, and twelve inches long, with end caps and tubing fittings.

The pumps 16, 18 force the reactants into the bottom of the reaction chamber or column. The pressure of the pumps 16, 18 forces the reacted mixture up out of the top of the reaction  
15 chamber 24, following between ten to twenty minutes admixing time of the reactants in the reaction chamber 24. The pumps 16, 18 are 1.6 gallon per hour capacity pumps.

The following are some examples that are submitted for the purpose of making it easier to understand the invention.

#### EXAMPLE 1

A solution containing 17.5% wt/wt of PBTC, 0.1% wt/wt sodium molybdate di-hydrate ( $\text{Na}_2\text{MoO}_4 \cdot 2\text{H}_2\text{O}$ ) in water was added to an equal volume of 7.5% wt/wt sodium chlorite ( $\text{NaClO}_2$ ) in water. After allowing the mixture to react for ten minutes, small aliquots  
25 were added to a liter of stirred irrigation water from a berry farm until the chlorine dioxide level reached 0.5 parts per million. After fifteen minutes, samples were taken for enumeration of bacteria on aerobic plate count agar. Approximately a 10,000 fold reduction in bacteria was achieved  
30 based on the initial bacterial content of the untreated irrigation water. Water samples treated with only the PBTC solution showed no decrease in bacterial counts.

## EXAMPLE 2

5 An irrigation system at a California vineyard carrying 1500  
gallons per minute of water was treated with the chemical  
composition in Example 1 resulting in a final concentration of  
10 0.2 ppm chlorine dioxide and 0.8 ppm PBTC. After several days,  
the bacterial counts increased due to dispersion and dislodging  
of established biofilms in the system. However, within a week of  
continuous treatment, the bacterial counts decreased 100 fold  
from the initial level of approximately 1000 organisms per ml to  
less than 10.

## EXAMPLE 3

15 A sample of irrigation water heavily contaminated with iron  
related bacteria (IRB), a major source of bio-fouling was treated  
with the solution of Example 1 to achieve a chlorine dioxide  
residual of 0.25 ppm. After a fifteen minute contact time, the  
treated water was analyzed for IRB using the BART (Biological  
Activity Reaction Test) test kit sold by Droycon Bioconcepts,  
Inc., Regina, Saskatchewan, Canada. All traces of IRB were  
eliminated vs. the control untreated water, which contained an  
20 estimated IRB level of 1,000 per ml.

One component of the reacted mixture may be sodium chlorite.  
Under acidic conditions this compound spontaneously forms  
chlorine dioxide, a powerful antimicrobial. Salts of  
hypochlorite or chlorine gas may be used in place of the sodium  
25 chlorite. This compound may be used to prepare hypochlorous acid  
in the reaction chamber 24. This reacted mixture is also a  
powerful antimicrobial. The second component may be an  
organophosphate compound such as 2-phosphonobutane-1,2,4-  
tricarboxylic acid (PBTC), CAS Registry No. 37971-36-1.  
30 Alternatively, the second component may be a mixture of mineral  
acids and antiscalant polymers such as polyacrylic acid or other  
polymeric compounds. The second component has the attributes of  
being acidic enough to convert sodium chlorite into chlorine

dioxide while remaining unaffected in the reaction mixture. At the same time it is an excellent mineral antiscalant.

Very few chelants and/or antiscaling compounds remain unaffected in the presence of even dilute amounts of oxidizing compounds. PBTC is one of the very few chelants that demonstrates acceptable stability in the presence of strong oxidizers. Furthermore, the reaction of PBTC with sodium chlorite might be greatly accelerated and reaction time greatly reduced, by the inclusion of small amounts of a catalyst such as, but not limited to, sodium molybdate in the PBTC component prior to admixing it with the sodium chlorite component.

According to an aspect of the invention, the generation and delivery of antiscalant, antimicrobial mixture is easily achieved on-site by metering the individual component solutions into the reaction vessel 24, either by positive pumping or by vacuum eduction, and introducing the resultant reaction mixture into the water stream or volume. In some installations, the reaction mixture may be introduced into a body of water in a tank as opposed to flowing water in a conduit.

The process of generating and delivering the reaction mixture may be conducted intermittently by use of timer controlled chemical feed pumps, or can be conducted continuously, by flow controlled pumping or eduction. Optimum conversion of the sodium chlorite compound into active chlorine dioxide requires at least several minutes of reaction time and, preferably, the use of a suitable catalyst, such as sodium molybdate. Accordingly, the reaction or mixing chamber 24 should be of a suitable volume to allow the two solutions or components to co-mingle and react for the desired length of time before exiting the reaction chamber 24, into the conduit 12 or a water tank.

The illustrated embodiment is only a single example of the present invention and, therefore, is non-limitive. It is to be understood that many changes in the particular structure,

